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ELECTROCOAGULATION TREATMENT FOR DAIRY EFFLUENT

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ABSTRACT

Dairy industry is one of the major industries causing water pollution. Considering the above problem an attempt has been made in the present paper to evaluate electro coagulation treatment effect on dairy effluent. The purpose of this study was to investigate the effects of Electrode Material on COD removal from Dairy Effluent. The study also bring out that electro coagulation with Aluminum electrodes was more effective than Mild Steel and Cast Iron electrodes.

KEYWORDS: Electrocoagulation, Dairy Effluent, Electrolytic Cell, Electrodes

INTRODUCTION

The Dairy Industry in India is expected to grow rapidly and have the waste generation and related environmental problems are also assumed increased importance. Poorly treated wastewater with high levels of pollutants caused by poor design, operation or treatment systems creates major environmental problems when discharge to surface water or land. Such problems include Contamination and deoxygenating of streams and waterways by direct discharge or run off of inadequately treated wastewater, Excessive concentration of nutrients such as nitrogen and phosphorous in surface and subsurface water bodies. This contribute to excessive growth of plants and algae blooms, which makes the downstream water unsuitable for domestic, agriculture and industrial use. Land degradation and damage to pastures and crops. Long term damage to soil production may arise from Excessive nutrient loading, High salinity, Low / High pH, Over application of wastewater to land resulting in contaminated ground water, Soil structure decline due to wastewater with high Sodium Adsorption Ratio, Clogging of soil by fats / solids from irrigated wastewater[2].

The Dairy Industry involves processing raw milk into products such as consumer milk, butter, cheese, yogurt, condensed milk, dried milk (milk powder) and ice-cream using processes such as pasteurization, bottling, filling in cans etc. The Dairy Industry is one of the most widely spread of all the industries. These vary from small receiving stations to large plants where most of the products made from milk are manufactured. Wastes from milk product manufacture contain milk solids in a more or less dilute condition, but in varying concentration. These solids enter the waste from almost all of the operations. In general, the wastes generated from Dairy Industry are: The washing and cleaning out of product remaining in the tank, trucks, cans, piping, tanks and other equipment is performed routinely after every processing cycle; Spillage is produced by leaks, overflow, freezing-on, boiling over, equipment malfunction or careless handling; Processing losses include Sludge discharge from clarifiers, Product wasted during pasteurized start-up, shut-down and product change-over, Evaporator entrainment, Discharges from bottles and washers, Splashing and container breakage in automatic packaging equipment and Product change-over in filling machines; Spoiled products, returned products or by-products such as whey wasted; Detergents and other compounds are used in the washing and

sanitizing solutions that are discharged as waste ; Entrainment of lubricants from conveyors, stackers and other equipment appear in the wastewater from cleaning operations; Routine operation of toilets, washrooms and restaurant facilities at the plant contribute waste; Waste constituents may be contained in the raw water which ultimately goes to waste; Non-dairy ingredients (such as sugar, fruits, flavors, nuts and fruit juices) utilized in certain manufactured products (include ice-cream, flavored milk, frozen desserts, yoghurt and others); Milk by-products that are deliberately wasted, significantly whey and sometimesbuttermilk[16].

The problem for most dairy plants is that waste treatment is perceived to be a necessary evil[7]; it ties up valuable capital, which could be better utilized for core business activity. Dairy effluent disposal usually results in one of three problems: (a) high treatment levies being charged by local authorities for industrial wastewater; (b) pollution might be caused when untreated wastewater is either discharged into the environment or used directly as irrigation water; and (c) dairy plants that have already installed an aerobic biological system are faced with the problem of sludge disposal. To enable the dairy industry to contribute to water conservation, an efficient and cost-effective wastewater treatment technology is critical.

The disadvantages associated with anaerobic systems for Dairy effluent are the high capital cost, long start-up periods, strict control of operating conditions, greater sensitivity to variable loads and organic shocks, as well as toxic compounds[18]. The operational temperature must be maintained at about 33–37°C for efficient kinetics, because it is important to keep the pH at a value around 7, as a result of the sensitivity of the methanogenic population to low values[19]. As ammonia-nitrogen is not removed in an anaerobic system, it is consequently discharged with the digester effluent, creating an oxygen demand in the receiving water. Complementary treatment to achieve acceptable discharge standards is also required.

In the Electro coagulation process, the coagulants are generated electrically and wastewater is treated in an electrochemical cell. When the system is connected to an external power source, sacrificial anodes are corrected due to oxidation in the solution and release coagulant cations (usually aluminum or iron) in the cell. In the Electro coagulation process the coagulating ions produced 'in situ' and it involves three successive stages: 1) Formation of coagulants by electrolytic oxidation of the sacrificial electrode. 2) Destabilization of the contaminants, particulate suspension, and breaking of emulsions. 3) Aggregation of the destabilized phases to form flocs. When a potential is applied from an external power source, the anode material undergoes oxidation, while the cathode will be subjected to reduction or reductive deposition of elemental metals. The mechanism of Electro coagulation is highly dependent on the chemistry of the aqueous medium, especially conductivity[17].

Advantages of Electro coagulation are Electro coagulation requires simple equipment and is easy to operate. The electrolytic processes in the Electro coagulation cell are controlled electrically with no moving parts, thus requiring less maintenance. Wastewater treated by Electro coagulation gives palatable, clear, colorless and odorless water. It is a low sludge producing technique. Sludge formed by Electro coagulation tends to be readily settable and easy to de-water, because it is composed of mainly metallic oxides/hydroxides. Flocs formed by Electro coagulation are similar to chemical floc, except that Electro coagulation floc tends to be much larger, contains less bound water, is acid-resistant and more stable, and therefore, can be separated faster by filtration. The Electro coagulation process avoids uses of chemicals, and so there is no problem of neutralizing excess chemicals and no possibility of secondary pollution caused by chemical substances added at high concentration as when chemical coagulation of wastewater is used. The gas bubbles produced

during electrolysis can carry the pollutant to the top of the solution where it can be more easily concentrated, collected and removed. The Electro coagulation technique can be conveniently used in rural areas where electricity is not available, since a solar panel attached to the unit may be sufficient to carry out the process[6].This study of Electro coagulation treatment of dairy effluent was tested and the COD removal efficiency was determined.

EXPERIMENTAL SETUP AND PROCEDURE

Electro coagulation reactor with electro desconnected in parallel was used in the experiments. The reactor having a volume of 0.4 liter was used. Aluminum plates, Cast Iron Plates, Mild Steel Plates were used as the electrodes for the experiments. A regulated direct current supply (0-30 V, 15 A) by Power Supplier was used for the experiments. The experimental setup is shown in Figure 1.

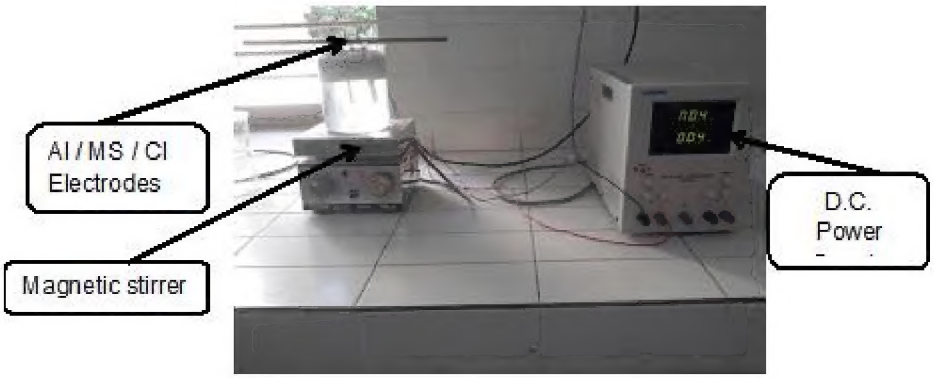

Figure 1: Electro-Coagulation Set up

400 ml of effluent sample was put in reactor. Effluent Samples were taken at different time intervals and filtered before analyzed. The water quality of dairy effluent such as COD was measured in each experimental run by standard methods[1].

RESULT AND DISCUSSIONS

Effect of Electrode Material

Effect of different Electrode Materials i.e. Mild Steel, Aluminum, Cast Iron etc. are shown in below Figure 2. As we seen in results of Table 1, maximum result got by Aluminum Electrode plates. In Dairy effluents as we seen in data, we got highest results and it is up to an avg. 68 %.

Table 1: Final Full Table of Electrocoagulation Treatment for Dairy Effluent

Raw COD (mg/l)	After Treatment COD (mg/l)		% COD Reduction	Plate Type	Submerge Plate Size (cm X cm)
	30 min	1 hr			
4505	---	4716	-4.68	Mild Steel	2.2 X 6.5
4480	1120	---	75	Aluminum	2.2 X 6.5
4640	2880	1920	58.62	Aluminum	2.2 X 6.5
4680	---	1480	68.37	Aluminum	2.2 X 6.5
4360	---	2284	47.61	Cast Iron	2.2 X 6.5
4460	2700	1520	65.91	Aluminum	2.2 X 6.5

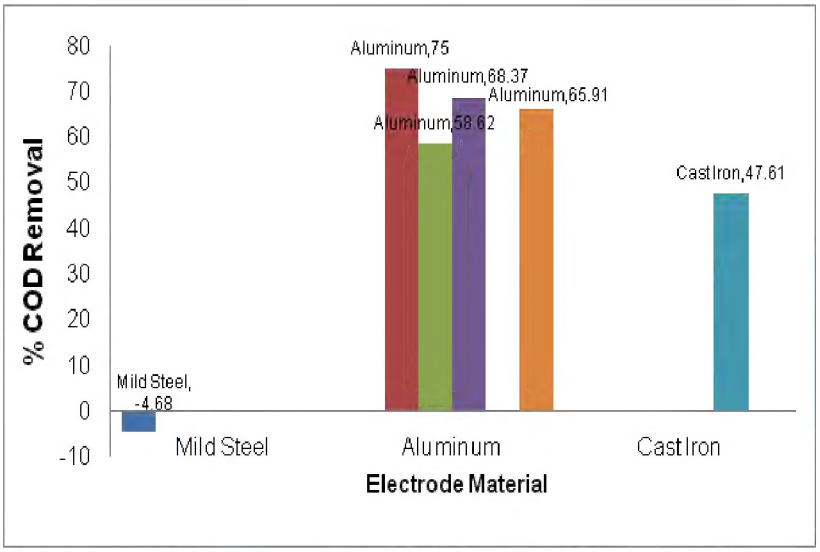

Figure 2: Effect of Different Electrode Materials on Dairy Effluent

CONCLUSIONS

Based on the present Lab-Scale Electro coagulation Treatment for Dairy Effluent, the following conclusions can be drawn:

- Maximum Removal of COD is obtaining Up to an Avg. 68% in 1hr of treatment by using Aluminum as Electrode material.
- Using Mild Steel as electrode Increases COD of effluent sample. So it is not useful for Dairy Effluent treatment.

As we got Maximum Results from Aluminum as an Electrode Material, So that we can use Electro coagulation Treatment with Aluminum Electrode for Dairy Effluents.

REFERENCES

1. APHA, AWWA and WPCF 1995, "Standard methods for the Examination of water and wastewater". 19th edition, jointly edited by Eaton, A.D.; Clesceri, L.S. and Grreenberg, A.E.
2. P Sharma, R Walia (2008), "Performance Evaluation of Wastewater Treatment Plant for Milk Based Food Industry"
3. Arceivala, J.S. and Asolekar, S.R. (3rd Edition), "Wastewater treatment for pollution control".
4. Arceivala, S. (1980), "Wastewater treatment and disposal". Marcel Dekker and CO., New York.
5. Banu, J.R.; Anandan, S.; Kaliappan, S. and Yeom, Ice-Tae (2008), "Treatment of dairy wastewater using anaerobic and solar photocatalytic methods", Solar Energy 3.
6. Bayramoglu M., Eyvaz M. and Kobya M. "Treatment of the textile wastewater by electro coagulation Economical evaluation", Bard A.J. "Standard Potential in Aqueous Solution", Marcel Decker Inc., New York, (1985), p. 63.Chemical Engineering
7. Robinson, T. The real value of dairy waste. Dairy Ind. Int. 1997, 62 (3), 21–23.

8. Berg van den, L. and Kennedy, K.J. (1983), "Dairy waste treatment with anaerobic stationary fixed film reactors". Water Sci. Tech. 15, 359-68.
9. Cordoba, P.R.; Sanchez, R.F. and Sineriz, F. (1984), "Treatment of dairy industry waste water with an anaerobic filter". Biotechnol. Lett. 6, 753-8.
10. "Environmental guidelines for the Dairy Processing Industry".
11. Punmia, B.C; Jain Ashok K. (2nd Edition), "Wastewater Engineering".
12. Ramalho, R.S. (1983), "Introduction to Wastewater Treatment Processes".
13. Rudolfs, W., "Industrial Waste Treatment".
14. Rusten, B.; Odegaard, H. and Lundar, A. (1992), "Treatment of dairy wastewater in a novel moving bed bio film reactor". Water Sci. Tech. 26, 703-11.
15. "The Environmental Impact of the animal product processing industries".
16. Thompson, T.G. and Meyer, G.E. (1998), "Waste management issues for dairy processors".
17. Mollah M .Y. A., Morkovsky P., Gomes J.A.G., Kesmez M., Parga J. and Cocke D.L. "Fundamentals, present and future perspectives of electro coagulation", Journal of Hazardous Materials B114 (2004): 199-210.
18. Britz, T.J.; Van Der Merwe, M.; Riedel, K.-H.J. Influence of phenol additions on the efficiency of ananaerobic hybrid digester treating land fill leachate. Biotech. Lett.1992, 14, 323–327.
19. Thirumurthi, D. Biodegradation in waste stabilization ponds (facultative lagoons). In Biological Degradation of Wastes; Martin, A.M., Ed. Elsevier Applied Sci.; New York, 1991; 231–235.